

NASA/CR-1998

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FAR UV OBSERVATIONS OF INTERSTELLAR SHOCKS

067103

NASA Grant NAG8-1074

Final Report

For the Period 1 March 1994 through 28 February 1998

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January 1998

Prepared for

National Aeronautics and Space Administration
Greenbelt, MD 20771

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The Smithsonian Astrophysical Observatory
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Harvard-Smithsonian Center for Astrophysics

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Code FA64, Marshall Space Flight Center, AL 35812

This grant, the “Far UV Observations of Interstellar Shocks”, covered analysis of Hopkins Ultraviolet Telescope data from the Astro-2 mission. The proposed research was aimed primarily at SNR shock waves, but the ASTRO-2 GO program was intended to make the GOs part of the instrument teams. The grant therefore covered extensive travel to Marshall Space Flight Center for mission simulations and the mission itself. In keeping with the unique nature of the ASTRO-2 GO program, I participated actively in the instrument team’s investigations of HH objects and cataclysmic variables.

Over the course of the Astro-2 mission, we obtained good observations of the supernova remnants SN1006 (1 position), Vela (3 positions), the Cygnus Loop (7 positions) and 0519-69 in the LMC (1 position) as part of this GI program, along with Puppis A (1 position), Vela (1 position), the Cygnus Loop (7 positions) and the Schweizer-Middleditch star (HUT PI program on SNRs). We also observed the Herbig-Haro object HH2 and about a dozen cataclysmic variables, including magnetic systems and dwarf novae.

This GI grant covered modest travel expenses and visits by Martin Laming and Rino Bandiera, along with visitor support for Jing Li and Pius Okeke for collaboration on the physics of SNR shocks as derived from the HUT spectra of SN1006, LMC-0519 and the Cygnus Loop, along with a study of the cataclysmic variable YZ Cnc. It has covered publication expenses and travel to the AAS meeting in June 1995 (Pittsburgh), the TEXMEX astrophysics meeting in Houston (1997), the Minneapolis SNR workshop (1997), and to Johns Hopkins University for data analysis.

We anticipate submitting papers on the non-radiative shock in northern Cygnus Loop, on the LMC Balmer-dominated remnant LMC 0519-69, on the radiative shocks in the Eastern Cygnus Loop (the XA region), and on the cataclysmic variable YZ Cnc over the course of the coming year. We have obtained extensive supporting data from ground-based telescopes for the Cygnus Loop spectra.

Refereed publications so far are:

“Detection of Ultraviolet Emission Lines in SN1006 with the Hopkins Ultraviolet Telescope”, J.C. Raymond, W.P. Blair, & K.S. Long 1995, ApJL, 454, L31

“Hopkins Ultraviolet Telescope Observations of U Geminorum Far From Outburst”, K.S. Long, W.P. Blair, & J.C. Raymond 1995, ApJL, 454, L39

“A Far Ultraviolet Spectrum of the Puppis A Supernova Remnant Using the Hopkins Ultraviolet Telescope” W.P. Blair, J.C. Raymond, K.S. Long, & G.A. Kriss 1995, ApJL, 454, L35

- “Observations of the Dwarf Nova VW Hydr in Quiescence with the Hopkins Ultraviolet Telescope” K.S. Long, W.P. Blair, I. Hubeny, & J.C. Raymond, 1995, ApJ, 466, 964
- “A Search for Fe III in SN 1006 Using the Hopkins Ultraviolet Telescope”, W.P. Blair, K.S. Long, and J.C. Raymond 1996, ApJ, 468, 871
- “Non-radiative Shocks Associated with SN 1006”, J.M. Laming, J.C. Raymond, B.M. McLaughlin & W.P. Blair 1996, ApJ, 472, 267
- “The Ultraviolet Spectrum of a Face-On Shock Wave in the Vela Supernova Remnant”, J.C. Raymond, W.P. Blair, K.S. Long, O. Vancura, R. Edgar, J. Morse, P. Hartigan & W.T. Sanders 1997, ApJ, 482, 881
- “Hopkins Ultraviolet Telescope Observations of H₂ Emission from HH2,” J.C. Raymond, W.P. Blair & K.S. Long 1997, ApJ, 489, 314
- “Hopkins Ultraviolet Telescope Observations of Hercules X-1”, B. Boroson, W.P. Blair, A.F. Davidsen, S.D. Vrtilik, J. Raymond, K.S. Long, and R. McCray, ApJ, 491, 59

Conference presentations include oral or poster versions of all but the Vela SNR paper at AAS or other meetings. A review paper titled “Molecular Hydrogen Emission from Herbig-Haro Objects” was prepared for a festschrift volume honoring A. Dalgarno. Papers at the 1995 and 1997 TEXMEX conferences (Mexico and Houston), the meeting on Supernova Remnant Shock Waves (Manchester, England), and the Minneapolis workshop on evolution of SNRs (1997) presented these spectra.